

## CHAPTER 2: ANALYTICAL FRAMEWORK

### TABLE OF CONTENTS

2.1	INTRODUCTION .....	2-1
2.2	BACKGROUND .....	2-4
2.3	MARKET AND TECHNOLOGY ASSESSMENT .....	2-4
2.3.1	Market Assessment .....	2-4
2.3.2	Technology Assessment .....	2-4
2.4	SCREENING ANALYSIS .....	2-5
2.4.1	Technology Screening .....	2-5
2.4.2	Baseline Equipment .....	2-5
2.5	ENGINEERING ANALYSIS .....	2-6
2.5.1	Design Option Approach .....	2-6
2.5.2	Efficiency-Level Approach .....	2-7
2.5.3	Cost-Assessment Approach .....	2-8
2.5.4	Other Regulatory Impacts on the Engineering Analysis .....	2-8
2.6	ENERGY USE AND END-USE LOAD CHARACTERIZATION .....	2-8
2.7	MARKUPS FOR EQUIPMENT PRICE DETERMINATION .....	2-8
2.8	LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSES .....	2-9
2.8.1	LCC Spreadsheet Model .....	2-9
2.9	SHIPMENTS ANALYSIS .....	2-10
2.10	NATIONAL IMPACT ANALYSIS .....	2-11
2.11	LIFE-CYCLE COST SUB-GROUP ANALYSIS .....	2-12
2.11.1	Purchase Price Increases .....	2-13
2.11.2	Consumer Participation .....	2-13
2.12	MANUFACTURER IMPACT ANALYSIS .....	2-13
2.12.1	Industry Characterization .....	2-13
2.12.2	Industry Cash Flow .....	2-14
2.12.3	Manufacturer Sub-Group Analysis .....	2-14
2.12.4	Interview Process .....	2-15
2.12.5	Competitive Impact Assessment .....	2-16
2.13	UTILITY IMPACT ANALYSIS .....	2-16
2.14	EMPLOYMENT IMPACT ANALYSIS .....	2-16
2.15	ENVIRONMENTAL ASSESSMENT .....	2-17
2.16	REGULATORY IMPACT ANALYSIS .....	2-18

## **LIST OF FIGURES**

Figure 2.1.1	Analyses for Distribution Transformer Energy-Efficiency Standards . . . . .	2-3
--------------	---	-----

## CHAPTER 2: ANALYTICAL FRAMEWORK

### 2.1 INTRODUCTION

This chapter provides a description of the general analytical framework used by the Department in developing standards and assessing the impacts for distribution transformers. The description addresses the methodology, the analytical tools, and the relationship between the various analyses conducted in the rulemaking. The objective of the rulemaking process is to determine minimum efficiency standards for distribution transformers that are technologically feasible and economically justified. In this context, economic justification includes consideration of the economic impact on manufacturers and consumers, the national benefits, the impacts on utilities, and the impacts from any lessening of competition. The Department will conduct several of these analyses following the Advance Notice of Proposed Rulemaking (ANOPR).

Figure 2.1.1 summarizes the analytical components of the standard-setting process. The focus of this figure is the third column, identified as “Analysis.” The columns labeled “Key Inputs” and “Key Outputs” indicate how the analyses fit into the rulemaking process, and how the analyses relate to each other. Key outputs are analytical results that feed directly into the standard-setting process. Dotted lines connecting analyses indicate types of information that feed from one analysis to another. Key inputs are the types of data and information that the analyses require. Some key inputs exist in public databases and DOE will also collect inputs from stakeholders or others with special knowledge. Inputs developed by the project team for the standards-setting process are presented and open for stakeholder review.

The analyses that the Department performed for the ANOPR include:

- a market and technology assessment to characterize the distribution transformer market and review techniques and approaches used to produce more efficient transformers;
- a screening analysis to identify design options that improve distribution transformer efficiency and to determine which should be evaluated and which should be screened out;
- an engineering analysis to estimate the relationship between the manufacturing cost of a transformer and its efficiency level;
- an energy use and end-use load characterization to generate energy use estimates and end-use load profiles of distribution transformers;
- a markup process to convert manufacturer sales prices to customer installed prices;
- a life-cycle cost (LCC) analysis to calculate, at the consumer level, the discounted savings in operating costs throughout the estimated average life of the distribution transformer, compared to any increase in the installed costs likely to result directly from the imposition of the standard. As a supporting or parallel analysis, a payback period (PBP) analysis is performed to calculate the amount of time it takes consumers to recover the assumed

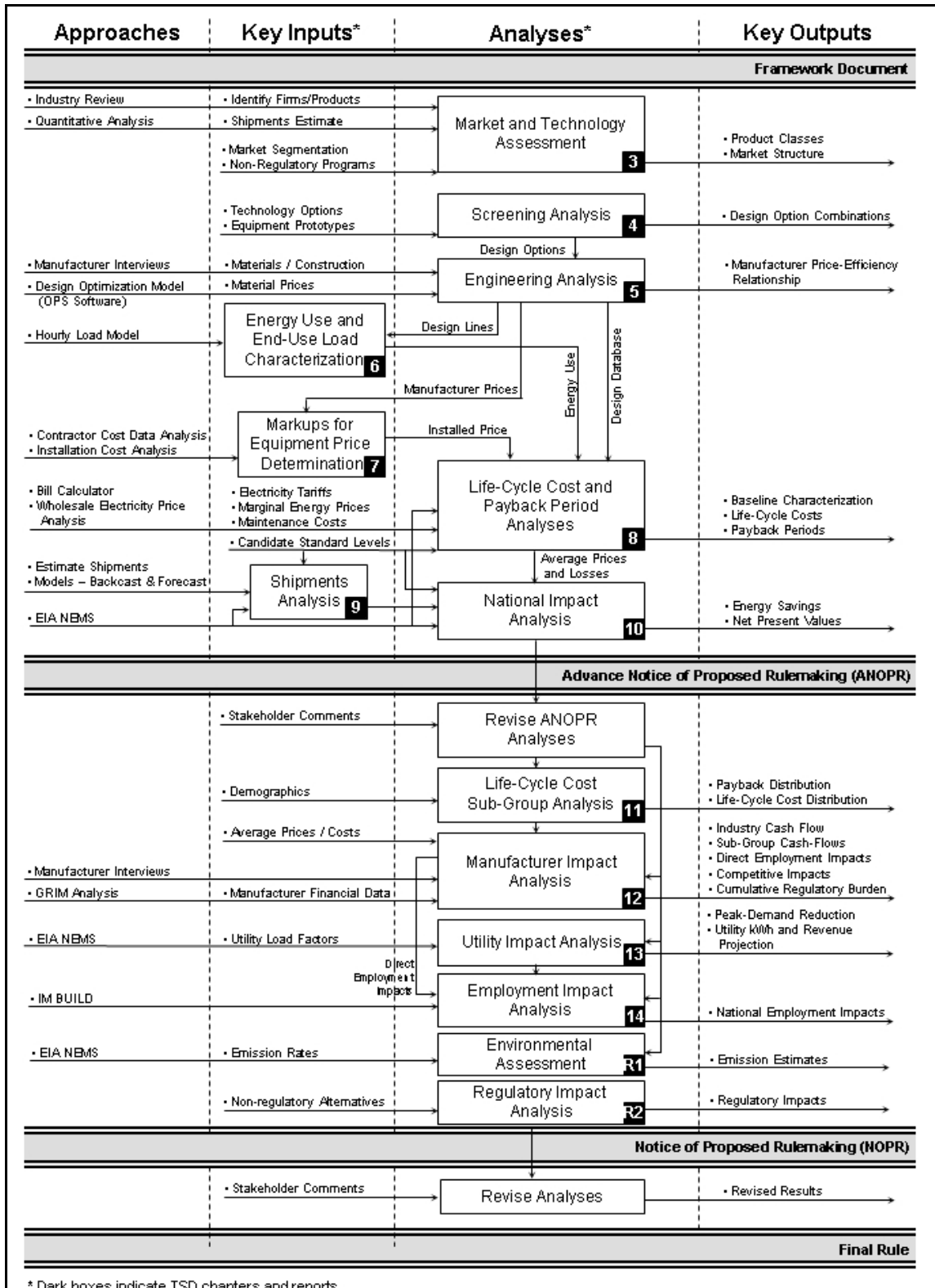
higher purchase expense of more energy-efficient equipment through lower operating costs;

- a shipments analysis to estimate shipments of distribution transformers over the time period examined in the analysis; and
- a national impacts analysis to assess the aggregate impacts at the national level of consumer payback, net present value (NPV) of total consumer LCC, national energy savings, and national employment.

The analyses that the Department will perform for the Notice of Proposed Rulemaking (NOPR), after publishing the ANOPR, include:

- an LCC sub-group analysis to evaluate impacts on identifiable groups of customers of distribution transformers, including various types of electric utilities or various types of commercial or industrial transformer purchasers or owners, who may be disproportionately affected by a national energy-efficiency standard;
- a manufacturer impact analysis (MIA) to estimate the financial impact of standards on distribution transformer manufacturers and to calculate impacts on competition, employment at the manufacturing plant, and manufacturing capacity;
- a utility impact analysis to estimate the effects of proposed standards on the installed capacity and generating base of electric utilities;
- an employment impact analysis to estimate the impacts of standards on net jobs eliminated or created in the general economy as a consequence of increased spending on the purchase price of transformers and reduced customer spending on energy;
- an environmental assessment to assess the impacts of proposed standards on certain environmental indicators; and
- a regulatory impact analysis to present major alternatives to proposed standards that could achieve comparable energy savings at a reasonable cost.

In response to comments it receives after publishing the NOPR, the Department may revise some of its analyses before publishing the Final Rule.



**Figure 2.1.1 Analyses for Distribution Transformer Energy-Efficiency Standards**

## **2.2 BACKGROUND**

As described in Chapter 1, in September, 1995, the Department announced a formal effort to consider further improvements to the process used to develop appliance efficiency standards. The Department called on energy efficiency groups, manufacturers, trade associations, state agencies, utilities, and other interested parties to provide input to this effort. As a result of this combined effort, the Department published *Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products* (the “Process Rule”), 10 CFR 430, Subpart C, Appendix A. The Process Rule outlined the procedural improvements identified by the interested parties, and included a review of the: 1) economic models, 2) analytical tools, 3) methodologies, 4) non-regulatory approaches, and 5) prioritization of future rules. The Process Rule recommended that the Department take into account uncertainty and variability by carrying out scenario or probability analysis. The following sections provide a general description of the analytical components of the improved rulemaking framework.

## **2.3 MARKET AND TECHNOLOGY ASSESSMENT**

The market and technology assessment characterizes the distribution transformer markets and existing technology options for making a transformer more efficient. Although the Department did not develop a detailed market and technology assessment for this Technical Support Document (TSD) on distribution transformers, the TSD discusses elements of the work completed.

### **2.3.1 Market Assessment**

When initiating a standards rulemaking, the Department develops information on the present and past industry structure and market characteristics of the product(s) concerned. This activity consists of both quantitative and qualitative efforts to assess the industry and products based on publicly available information. Issues to be addressed include: 1) national transformer shipments; 2) identification of largest players in the transformer industry; 3) discussion of existing non-regulatory efficiency improvement initiatives; 4) developments around standards in States and neighboring countries; and 5) trends in product characteristics and retail markets. The information collected serves as resource material to be used throughout the rulemaking.

### **2.3.2 Technology Assessment**

This chapter provides information about existing technology options and designs to construct more energy-efficient distribution transformers. In consultation with interested parties, the Department developed several technology options and designs for consideration. Some examples of these design options include: 1) higher-grade core steels, 2) use of different conductors, and 3) adjustments to core dimensions and the number of turns.

As described in Chapter 4, the Department reviewed and analyzed some emerging technologies for distribution transformers (e.g., superconducting materials). Although these technologies are not generally considered commercially available, the Department discusses their potential impact on the distribution transformer industry.

Another key part of the technology assessment is the determination of the product classes that will be used in the rulemaking. Distribution transformers are divided into classes using the following criteria: a) the type of energy used, b) capacity, and c) performance-related features that affect consumer utility or efficiency. Different efficiency standards apply to different product classes. In general, DOE defined classes using information obtained from manufacturers, trade associations, and other interested parties.

## **2.4 SCREENING ANALYSIS**

The screening analysis (Chapter 4) reviews various technologies with regard to whether they: 1) are technologically feasible, 2) are practicable to manufacture, install and service, 3) do not have an adverse impact on product utility or product availability, and 4) do not adversely impact health and safety.

### **2.4.1 Technology Screening**

The Department developed an initial list of efficiency enhancement design options from the technologies identified in the technology assessment. Then the Department, in consultation with interested parties, reviewed the list to determine if they are practicable to manufacture, install and service, would adversely affect product utility or product availability, or would have adverse impacts on health and safety. The Department used efficiency enhancement design options that pass the four screening criteria in the engineering analysis. It did not consider those options that fail one or more of the screening criteria in the analysis. Chapter 4 discusses which design options are considered in the distribution transformer engineering analysis. Also included is a list of emerging technologies which could impact future distribution transformer manufacturing costs.

### **2.4.2 Baseline Equipment**

To analyze design options for energy-efficiency improvements, the Department typically defines a baseline unit against which to compare more-efficient units. For products with existing standards, the baseline unit will usually be a unit just meeting the standard. However, since distribution transformers do not have an existing efficiency standard, the Department developed an approach based on estimated purchases in the current environment, producing a distribution of efficiencies for a baseline scenario. The Department established the baseline scenario as part of the LCC analysis.

## **2.5 ENGINEERING ANALYSIS**

The engineering analysis (Chapter 5) develops cost-efficiency relationships for distribution transformers, estimating manufacturer costs of achieving increased efficiency levels. Manufacturing costs are used as the means of determining retail prices in the life-cycle cost analysis, and are needed for the MIA. The engineering analysis also determines the maximum technologically feasible energy efficiency level.

In general, the engineering analysis estimates the efficiency improvement potential of the individual or combinations of design options that passed the four criteria in the screening analysis. The Department, in consultation with stakeholders, uses the most appropriate method to determine the manufacturing cost-energy efficiency relationship. This cost-efficiency relationship developed in the engineering analysis is used in the LCC analysis.

As described in Chapter 1, the Department will consider those distribution transformers that are designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Therefore, an important role of the engineering analysis is to identify the maximum technologically feasible level. The maximum technologically feasible level is one that can be reached by the addition of efficiency improvements and/or design options, both commercially feasible and in prototypes, to the baseline units. The Department believes that the design options comprising the maximum technologically feasible level must have been physically demonstrated in at least a prototype form to be considered technologically feasible.

In general, three methodologies can be used to generate the manufacturing costs needed for the engineering analysis. These methods are:

1. the design-option approach - reporting the incremental costs of adding design options to a baseline model;
2. the efficiency-level approach - reporting relative costs of achieving energy efficiency improvements; and
3. the reverse engineering or cost-assessment approach - involves a "bottoms-up" manufacturing cost assessment based on a detailed bill of materials derived from transformer tear-downs.

The Department considers public comments in determining the best approach for a rulemaking.

### **2.5.1 Design Option Approach**

The design option approach identifies individual or combinations of design options which increase efficiency. These increases in efficiency are typically either based on manufacturer or component supplier estimates or on engineering computer simulation models. The incremental manufacturing costs of adding design options to a baseline model are then determined. The Department added individual or combinations of design options to the baseline model in ascending order of cost-effectiveness. Typically, the payback period is used to establish a design

option's cost-effectiveness and is determined by the ratio of the change in total consumer cost to the change in operating cost.

The primary advantage of the design option approach is its ability to analyze individual technologies. The approach is transparent in that the impact of any single technology on cost and efficiency is explicit. An additional advantage is its ability to incorporate designs that have been demonstrated to perform in prototypes but have yet to be utilized in equipment currently available on the market. Thus, maximum technologically feasible designs are more easily established than in the efficiency level approach.

Although individual technologies can be assessed, the design option approach tends to be complex. The material combinations considered may be combined in ways not typically utilized by manufacturers, making it difficult to assess the impact of a design on system cost and efficiency. In order to determine a technology's impact on system efficiency, computer simulation models are typically employed, but these models exhibit at least some level of inaccuracy, and only approximate the performance of actual manufactured units.

Another drawback to the design option approach is its imperfect compatibility with the manufacturing impact analysis. The Department recognizes that the manufacturer selling price information derived in a component-based analysis does not reflect the variability in baseline units, design strategies and cost structures that can exist between manufacturers. Therefore, in the manufacturing impact analysis (see Chapter 12), the Department may need to derive additional manufacturing cost estimates, using other approaches developed in consultation with interested parties.

## **2.5.2 Efficiency-Level Approach**

The efficiency-level approach, which the Department did not select for the distribution transformer engineering analysis, establishes the relationship between manufacturer sales price and increased efficiency at incremental increases in efficiency levels. Manufacturers provide incremental manufacturer cost data for incremental increases in efficiency. Cost-efficiency curves can be easily constructed to clearly identify at what point manufacturers are incurring significant costs to raise efficiency. Additionally, the efficiency-level approach allows manufacturers the ability to supply detailed cost data without revealing their unique design strategies for achieving increased efficiency levels.

The simplicity of the efficiency-level approach is also its primary drawback. Namely, since technological details are not provided, it is extremely difficult to verify whether the costs provided for each specific efficiency level are truly representative of the costs for that level. In addition, prototypical designs become difficult to evaluate and maximum technologically feasible designs are then difficult to ascertain. As a result, some other type of supplementary analysis is likely needed in order to verify the accuracy of the costs supplied through the efficiency-level approach.

### **2.5.3 Cost-Assessment Approach**

The cost-assessment approach, also called the ‘reverse engineering approach,’ is based around a component-based technology-costing of the various technological paths manufacturers typically use to achieve increased product energy efficiency. Under this type of analysis, DOE physically analyzes, i.e., dismantles actual pieces of equipment on the market, component-by-component to determine what technologies and designs manufacturers employ to increase efficiency. The Department then uses independent costing methods and manufacturer and component supplier data to estimate the costs of the components. This approach has the distinct advantage of using “real” market equipment to establish the technologies that are used by manufacturers and to establish the manufacturing cost to produce more-efficient units.

The primary disadvantage of reverse engineering is the time and effort required to analyze “real” equipment. Several models from a diverse range of manufacturers may have to be assessed in order to ensure that an accurate representation of technological paths for increasing efficiency are identified. In addition, since only equipment in the market is analyzed, prototypical designs may not be captured by the analysis, thus making it difficult to establish maximum technologically feasible designs.

### **2.5.4 Other Regulatory Impacts on the Engineering Analysis**

In conducting an engineering analysis, regulatory changes sometimes occur outside of the standards-setting process that can impact product manufacturing. Some of these changes can also affect the efficiency of the product. The Department attempts to identify all “outside” issues that can impact the engineering analysis.

## **2.6 ENERGY USE AND END-USE LOAD CHARACTERIZATION**

The energy use and end-use load characterization analysis (Chapter 6) produces energy use estimates and end-use load shapes for distribution transformers. The energy use estimates enable evaluation of energy savings from the operation of distribution transformer equipment at various efficiency levels, while the end-use load characterization allows evaluation of the impact on electricity monthly and peak demand from the operation of transformers. The analysis produces a distribution of results for a variety of building types and uses covering a range of climate locations in order to represent the diversity of use, and performance, of distribution transformer equipment.

## **2.7 MARKUPS FOR EQUIPMENT PRICE DETERMINATION**

Chapter 7 describes the process used to determine the installed price of distribution transformers. The Department derives this by applying markups to the manufacturer selling price from the engineering analysis (Chapter 5). Markup, shipping costs, sales tax, and installation costs are the costs associated with bringing a manufactured transformer into service as an

installed piece of electrical equipment. Since electric utilities typically purchase liquid-immersed transformers directly from manufacturers, there are no handling markups applied to the manufacturer selling price. Dry-type transformers, on the other hand, are subject to both distributor and contractor markups. Both liquid-immersed and dry-type distribution transformers are subject to shipping, sales tax and installation markups.

## **2.8 LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSES**

Chapter 8 describes the LCC analysis, which calculates the discounted savings in operating costs throughout the estimated average life of the covered product compared to any increase in the installed cost for the product likely to result directly from the imposition of a standard. In determining economic justification, the Energy Policy and Conservation Act (EPCA) directs the Department to consider a number of different factors, including the economic impact of potential standards on consumers (42 U.S.C. 6295 (o)(2)(B)(i)).

To consider these requirements, the Department calculated changes in LCC to the consumers that are likely to result from the candidate standard level as well as a simple payback period. The Department calculated both the LCC and the PBP in a Monte Carlo framework, so results are represented by distributions. The effect of standards on individual consumers includes a change in operating expense (usually decreased) and a change in purchase price (usually increased). The Department analyzed the net effect by calculating the change in LCC as compared to the base case. Inputs to the LCC calculation include the installed consumer cost (purchase price plus shipping, sales tax and installation cost), operating expenses (energy and maintenance costs), lifetime of the equipment, and a discount rate.

Chapter 8 also describes the PBP Analysis, which calculates the amount of time needed to recover the additional cost that consumers pay for increased efficiency. Numerically, the simple payback period is the ratio of the increase in purchase price to the decrease in annual energy costs.

### **2.8.1 LCC Spreadsheet Model**

The Department developed an LCC spreadsheet model to calculate the economic impacts of more efficient distribution transformers. The LCC spreadsheet estimates the economic impacts on the consumer (i.e., the owner or purchaser) of a transformer by calculating the difference between pairs of transformers. In these pairs, one transformer is a baseline model representing a typical transformer that would be purchased in the current environment (i.e., without an efficiency standard). The Department selects the other transformer model in two ways:

- For those purchasers conducting Total Owning Cost (TOC) evaluations, the transformer corresponds to the lowest-TOC design meeting a particular energy efficiency standard.

- For those purchasers not basing purchase decisions on TOC evaluation, the second transformer in the pair is the one with minimum first cost meeting the specific energy efficiency standard which the Department decides to evaluate.

The LCC spreadsheet compares the life-cycle costs for a representative unit from the baseline scenario with life-cycle costs for more efficient units. Baseline units are those designs that customers would choose in the absence of a new efficiency standard. Identifying a specific baseline for transformers is complicated for two reasons: 1) the lack of existing mandatory efficiency standards, and 2) the wide variability in designs available to potential purchasers at any given efficiency level. To address these issues, the Department developed an LCC model that uses distributions of inputs to produce a representative range of transformer costs and efficiencies. That representative distribution of costs and efficiencies determines the baseline LCC scenario.

The Department used the LCC spreadsheet to determine the effects of more-efficient units on operating expenses (usually decreased) and purchase prices (usually increased) of distribution transformers. The LCC spreadsheet focuses on a distribution of potential transformer designs for selected efficiency levels (see Chapter 5, *Engineering Analysis*, for a discussion of the potential designs). These designs differ in cost, no-load losses, and load losses. Using the LCC spreadsheet, the Department calculated operating costs, taking into account distributions in loading and marginal electricity prices, and compared several potential candidate standard levels.

For the LCC analysis, DOE used a spreadsheet model developed in Microsoft Excel® combined with Crystal Ball® (a commercially available software program for conducting a Monte Carlo analysis). The model uses a Monte Carlo simulation (described in Appendix 8-B) to perform the analysis, considering uncertainty and variability. The LCC spreadsheet is organized so that users can enter ranges (or probability distributions) for each input variable needed to perform the calculations.

The Department calculated the payback period based on the same inputs used for the LCC analysis (with the difference that it based the values only on the first year the standard takes effect). The output is a probability distribution of payback periods, including the mean and median payback period as well as the minimum and maximum payback periods. Additional information is available in Chapter 8 and the LCC spreadsheets are available on the DOE website:  
[http://www.eere.energy.gov/buildings/appliance\\_standards/commercial/dist\\_transformers.html](http://www.eere.energy.gov/buildings/appliance_standards/commercial/dist_transformers.html).

## 2.9 SHIPMENTS ANALYSIS

One of the more important components of any estimate of future impacts from energy efficiency standards is transformer shipments (Chapter 9). Forecasts of shipments for the base case and each potential standard case need to be obtained as an input to the national energy savings (NES) model. The Department chose an accounting model method to prepare shipment

scenarios for the base case and the candidate standard levels. The model keeps track of the aging and replacement of transformer capacity given a projection of future transformer sales growth. New transformer capacity demand is created by growth in electrical demand. Transformer shipments, a retirement function, and initial number of transformers in service influence how transformers in service and supply of transformer capacity changes over time.

Shipments are organized into two categories: replacements and new capacity. Replacements occur when old transformers break down, corrode, are struck by lightning, or otherwise need to be replaced. New capacity purchases occur due to increases in electricity use that may be driven by increasing population, increasing commercial and industrial activity, or growth in electricity distribution systems. The model starts with an estimate of the overall growth in transformer capacity and then estimates shipments for particular design lines and transformer sizes using estimates of the relative market share for different design and size categories. Chapter 9 provides a detailed description of how DOE conducted its shipments forecasts.

## **2.10 NATIONAL IMPACT ANALYSIS**

National energy savings and net present value impacts are the cumulative energy and economic effects of a transformer energy conservation standard (Chapter 10). The Department projected the impacts from the year the standard would take effect through a selected number of years in the future. The Department analyzed energy savings, energy cost savings, equipment costs, and net present value of savings (or costs) for each candidate standard level. The national energy and cost savings (or increases) that would result from energy conservation standards depend on the projected energy savings per transformer and the anticipated numbers of transformers sold. The Department created base case transformer shipments projections that include units at various efficiency levels. It based the projections on historical information plus forecasts of market influences, national economic growth, and electricity consumption. The Department then derived energy savings for various candidate standard levels from the cost-efficiency schedules.

To make the analysis more accessible and transparent to all stakeholders, DOE used a Microsoft Excel® spreadsheet model to calculate the NES and the NPV (i.e., national economic costs and savings from new standards). Users can change input quantities within the spreadsheet to test the impact of alternative input assumptions. Unlike the LCC analysis, the NES spreadsheet does not use distributions for inputs or outputs. Users can demonstrate sensitivities by running different scenarios using the spreadsheet. The NES spreadsheet model is available on the DOE website:

[http://www.eere.energy.gov/buildings/appliance\\_standards/commercial/dist\\_transformers.html](http://www.eere.energy.gov/buildings/appliance_standards/commercial/dist_transformers.html)

As discussed in Chapter 10, the national impact analysis assesses the NPV of total consumer LCC, energy savings, and direct and indirect employment impacts. The Department conducted an assessment of the aggregate impacts at the national level for the ANOPR. Analyzing impacts of Federal energy-efficiency standards requires a comparison of projected

U.S. energy consumption with and without standards. The base case, which is the projected US energy consumption without standards, includes the mix of efficiencies being sold at the time the standard becomes effective.

The Department estimated national energy consumption for each year beginning with the expected effective date of the standard. The Department calculated national annual energy savings as the difference between two projections: a base case and a standards case. Analysis included estimated energy savings by fuel type used for generating electricity. The Department estimated energy consumption and savings based on site energy (kWh of electricity), and then converted the electricity consumption and savings to primary energy consumption.

## **2.11 LIFE-CYCLE COST SUB-GROUP ANALYSIS**

The Department will conduct the LCC sub-group analysis after the ANOPR and report the results in the NOPR.

While DOE expects distribution transformer energy conservation standards to reduce overall costs to the economy and consumers, there may be groups of consumers who see some increase in cost. In the next phase of the rulemaking, DOE will consider the results from the LCC analysis to evaluate the cost impacts on consumer sub-groups, such as owners and operators of different types of buildings, and other categories of transformer owners, including utilities, to see if they are differentially affected by potential energy conservation standards in a significant manner.

The analysis of these subgroups of transformer owners depends on identifying characteristics related to transformer use or economics that sets the subgroup apart from other transformer owners. The Department will analyze the effects on these groups by comparing the transformer owners' capital and operating costs with and without an energy conservation standard. The Department will use LCC analysis methods for consumer sub-group analysis by modifying cost assumptions to reflect the situations of the subgroups. Factors that could result in differential impacts to subgroups include differences in energy prices and transformer loading.

The Department plans to evaluate variations in regional energy prices, variations in energy use, and variations in installation costs that might affect the net present value of a standard to consumer sub-populations. To the extent possible, DOE obtains estimates of the variability in each input quantity and considers this variability in its calculation of consumer impacts. The analysis is structured to answer questions such as: How many companies are better off with standards and by how much? How many companies are not better off and by how much? The Department discusses the variability in each input quantity and likely sources of information with the interested parties.

### **2.11.1 Purchase Price Increases**

The Department will be sensitive to purchase price increases to avoid negative impacts to identifiable population groups. Additionally, the Department will assess the likely impacts of purchase price increases on product sales.

### **2.11.2 Consumer Participation**

The Department seeks to inform and involve consumers and consumer representatives in the process of developing standards. This includes notification of consumer representatives during the rulemaking process and, where appropriate, seeking direct consumer input.

## **2.12 MANUFACTURER IMPACT ANALYSIS**

The Department will conduct the MIA after the ANOPR and report the results in the NOPR. This analysis will estimate the financial impact of standards on distribution transformer manufacturers and also calculate the impact of standards on competition, direct employment, and manufacturing capacity within the industry. Three important elements of the approach are the preparation of an industry cash flow, the development of a process to consider sub-group cash flow, and the design of a guide to interview manufacturers and others in gathering information.

The policies outlined in the Process Rule resulted in substantial revisions to the analytical framework to be used in performing the MIA for each rulemaking. The Department intends to conduct the MIA in three phases. Phase 1 consists of two activities, namely, preparation of an industry characterization and identification of issues. Phase 2 evaluates the industry from a macro perspective. In this phase, the DOE will use Government Regulatory Impact Model (GRIM) to perform an industry cash flow analysis. Phase 3 involves repeating the process described in Phase 2 (the industry cash-flow analysis) but on different sub-groups of manufacturers. Phase 3 also entails calculating additional impacts on competition, direct employment, and manufacturing capacity.

### **2.12.1 Industry Characterization**

Phase 1 of the MIA consists of collecting pertinent financial and market information. This activity involves both quantitative and qualitative efforts. Data gathered include market share, corporate operating ratios, wages, employment, and production cost ratios. The Department incorporates these data into the engineering analysis in to estimate equipment production costs and distribution markups. Sources of information typically used for phase 1 include experts from industry as well as reports published by industry groups, trade journals, the U.S. Census Bureau, and SEC 10-K filings.

### **2.12.2 Industry Cash Flow**

Increased efficiency standards affect manufacturers in three ways: 1) by requiring additional investment, 2) by raising production costs, and 3) by affecting revenue because of higher prices and, possibly, lower quantities sold. To quantify these manufacturer impacts, the Department performs an industry cash flow analysis using the GRIM. Usually this analysis will use manufacturing costs, shipments forecasts, and price forecasts developed for the LCC and NES analyses. The Department will develop financial information, also required as an input to GRIM, based on publicly available data and manufacturer information confidentially submitted to the Department's contractor.

The GRIM analysis uses a number of factors—annual expected revenues; manufacturer costs such as cost of selling, general and administrative (SG&A); property taxes; and capital expenditures related to depreciation, new standards, and maintenance—to arrive at a series of annual cash flows beginning from before implementation of standards and continuing explicitly for several years after implementation. The Department calculated industry net present values by discounting the annual cash flows from the period before implementation of standards to some future point in time.

### **2.12.3 Manufacturer Sub-Group Analysis**

Assessment of impacts on sub-groups of manufacturers is Phase 3 of the MIA. Using industry “average” cost values is not adequate for assessing the variation in impacts among sub-groups of manufacturers. Smaller manufacturers, niche manufacturers, or manufacturers exhibiting a cost structure largely different from industry averages could be affected differently. Ideally, the Department would consider the impact on every firm individually. In highly concentrated industries this may be possible. In industries having numerous participants, the Department uses the results of the industry characterization to group manufacturers exhibiting similar characteristics. The financial analysis of the “prototypical” firm performed in the Phase 2 industry analysis can serve as a benchmark against which manufacturer sub-groups can be analyzed.

The Department will use the manufacturing cost data collected for the engineering analysis to the extent practical in the sub-group impact analysis. To be useful, however, these data should be disaggregated to reflect the variability in costs between relevant sub-groups of firms.

The Department will conduct detailed interviews with manufacturers to gain insight into the potential impacts of standards. During these interviews, the Department will solicit the information necessary to evaluate cash flows and to assess impacts on competition, direct employment and manufacturing capacity. The Department will also consider company-specific cumulative burden.

#### **2.12.4 Interview Process**

The revised rulemaking process provides for greater public input and improved analytical approaches, with particular emphasis on earlier and more-extensive information gathering from interested parties. The proposed three-phase MIA process will draw on multiple information sources, including structured interviews with manufacturers and a broad cross-section of interested parties. Interviews may be conducted in any and all phases of the analyses as determined in Phase 1 of the MIA.

The interview process has a key role in the MIAs, since it provides an opportunity for manufacturers to privately express their views on important issues. A key characteristic of the interview process is that it is designed to allow confidential information to be considered in the rulemaking process.

The initial industry characterization will collect information from relevant industry and market publications, industry trade organizations, company financial reports, and product literature. This information will aid in the development of detailed and focused questionnaires, as needed, to perform all phases of the MIAs.

The Phase 3 (sub-group analysis) questionnaire will solicit information on the possible impacts of potential efficiency levels on manufacturing costs, product prices, and sales. Evaluation of the possible impacts on direct employment, capital assets, and industry competitiveness will also draw heavily on the information gathered during the interviews. The questionnaires will solicit both qualitative and quantitative information. The Department will request supporting information whenever applicable.

Interviews will be scheduled well in advance in order to provide every opportunity for key individuals to be available for comment. Although a written response to the questionnaire is acceptable, an interactive interview process is preferred because it helps clarify responses and provides the opportunity for additional issues to be identified.

The Department will request interview participants to identify all confidential information provided in writing or orally. Approximately two weeks following the interview, DOE will provide an interview summary to give participants the opportunity to confirm the accuracy and protect the confidentiality of all collected information. All the information transmitted will be considered, when appropriate, in the Department's decision-making process. However, DOE will not make confidential information available in the public record.

The Department's contractor will collate the completed interview questionnaires and prepare a summary of the major issues and outcomes. The Department will seek public comment on the outcome of the interview process.

### **2.12.5 Competitive Impact Assessment**

Executive Order 12866 directs the Department to consider any lessening of competition that is likely to result from standards. It further directs the Attorney General to gauge the impacts, if any, of any lessening of competition. The Department will make an effort to gather and report firm-specific financial information and impacts. The competitive analysis will focus on assessing the impacts to smaller, yet significant, manufacturers. The Department will base the assessment on manufacturing cost data and on information collected from interviews with manufacturers, consistent with Phase 3 of the MIA. The Department of Justice (DOJ) has offered to help in drafting questions to be used in the manufacturer interviews. These questions will pertain to the assessment of the likelihood of increases in market concentration levels and other market conditions that could lead to anti-competitive pricing behavior. The manufacturer interviews will focus on gathering information that would help in assessing asymmetrical cost increases to some manufacturers, increased proportion of fixed costs potentially increasing business risks, and potential barriers to market entry (e.g., proprietary technologies).

### **2.13 UTILITY IMPACT ANALYSIS**

The Department will conduct the utility impact analysis after the ANOPR and report the results in the NOPR. In addition to the economic impacts on electric utilities, as consumers of distribution transformers, standards could affect utilities through the reduction in net generation resulting from the increased transformer efficiency of their electricity customers who purchase their own transformers. To perform the utility impacts analysis, the Department will use the BT (Building Technologies) version of the Energy Information Administration (EIA)'s National Energy Modeling System (NEMS). NEMS<sup>1</sup> is a large, general equilibrium energy-economy model of the U.S. that EIA has developed over several years, primarily for the purpose of preparing the *Annual Energy Outlook (AEO)*.<sup>2</sup>

NEMS produces a widely recognized baseline forecast for the U.S. through 2020 and is available in the public domain. Typical NEMS output includes forecasts of electricity sales and prices. The Department will conduct the utility analysis by comparing NEMS-BT output for various distribution transformer standard levels with the latest *AEO* forecasts. The comparison between NEMS-BT and the *AEO* forecasts will incorporate time-differentiated load impacts of transformer standards. The time-differentiated load impact estimate will use load shape information from the LCC analysis, and national energy use impact forecasts from the NES analysis. Other assumptions used in the *AEO* also will serve as the basic assumptions applied to the analysis of the impacts of energy conservation standards on utilities.

### **2.14 EMPLOYMENT IMPACT ANALYSIS**

The Department will conduct the employment impact analysis after the ANOPR and report the results in the NOPR. The Process Rule directs DOE to consider employment impacts in selecting a proposed standard. The Department will estimate the impacts of standards on

employment for transformer manufacturers, relevant service industries, energy suppliers, and the economy in general. The Department separates employment impacts into direct and indirect impacts. Direct employment impacts would result if standards led to a change in the number of employees at transformer manufacturing plants and related supply and service firms. The MIA discusses direct impacts. Indirect impacts are impacts on the national economy other than in the manufacturing sector DOE is regulating (including supply and service firms). Indirect impacts may result from both expenditures shifting among goods (substitution effect), and income changing, which will lead to a change in overall expenditure levels (income effect).

An important indirect employment effect may arise from shifting investment from the energy sector into more (or less) labor-intensive industries. The Department defines indirect employment impacts from standards as net jobs eliminated or created in the general economy as a consequence of increased spending to purchase distribution transformers and reduced spending to pay utility costs. The Department expects new equipment standards to increase a transformer's purchase price, which includes retail price, sales tax, and installation. The Department expects the same standards to decrease energy consumption, and therefore reduce expenditures for energy. Over time, the increased purchase price may be paid back through energy savings. Consumers may spend the savings in energy expenditures on other items. Using an input/output model of the U.S. economy, this analysis seeks to estimate the effects on different sectors, and the net impact on jobs. The Department will estimate national impacts for major sectors of the U.S. economy. The Department will use public and commercially available data sources and software to estimate employment impacts. The Department will analyze at least three scenarios to bound the range of uncertainty in future energy prices. All methods and documentation will be available for review when DOE conducts the employment impact analysis for the NOPR.

## **2.15 ENVIRONMENTAL ASSESSMENT**

The Department will conduct the environmental assessment after the ANOPR and report the results in the NOPR. The Environmental Assessment is required pursuant to the National Environmental Policy Act of 1969 (NEPA)(42 U.S.C. 4321 et seq.), regulations of the Council on Environmental Quality (49 CFR parts 1500-1508), the Department regulations for compliance with NEPA (10 CFR part 1021), and the Secretarial Policy on the National Environmental Policy Act (June 1994).

The main environmental concern addressed is emissions from fossil fuel-fired electricity generation. Power plant emissions include oxides of nitrogen ( $\text{NO}_x$ ) and sulfur ( $\text{SO}_2$ ), as well as carbon dioxide ( $\text{CO}_2$ ). The first two are major causes of acid precipitation, which can affect humans by reducing the productivity of farms, forests, and fisheries, decreasing recreational opportunities and degrading susceptible buildings and monuments. Nitrogen oxides are also precursor gases to urban smog and are particularly detrimental to air quality during hot, still weather. Carbon dioxide emissions are believed to contribute to raising the global temperature via the "greenhouse effect."

The major environmental effects of transformer energy conservation standards would result from reduced electrical energy consumption, and would take the form of reduced emissions from the operation of power plants. Analyses for previous standards have reported reductions in energy-related emissions of SO<sub>2</sub>, NO<sub>x</sub>, and CO<sub>2</sub>. The Department will estimate the emission impacts at the national level.

## **2.16 REGULATORY IMPACT ANALYSIS**

The Department will conduct the regulatory impact analysis after the ANOPR, and will report the results in the NOPR. The Department will prepare a draft regulatory analysis pursuant to E.O. 12866, *Regulatory Planning and Review*, which will be subject to review under the Executive Order by the Office of Information and Regulatory Affairs (OIRA) 58 FR 51735 (October 4, 1993). The Department identified eight major alternatives as representing feasible policy options to achieve consumer product energy efficiency. The Department will evaluate each alternative in terms of its ability to achieve significant energy savings at a reasonable cost, and will compare these results to the effectiveness of the rule.

Under the *Process Rule*, the Department is committed to continually explore non-regulatory alternatives to standards. The list below indicates those alternatives the Department intends to examine for this rulemaking. The Department will seek comments on this approach. Through manufacturer interviews and literature searches, the Department will compile information on burdens on manufacturers from existing and impending regulations affecting distribution transformers. The Department also seeks input from stakeholders regarding other regulations it should consider. The Department intends to examine the following non-regulatory alternatives to standards:

- No regulatory action
- Consumer tax credits
- Manufacturer tax credits
- Performance standards
- Rebates
- Voluntary energy-efficiency targets
- Early replacement
- Government bulk procurement

## REFERENCES

1. U.S. Department of Energy-Energy Information Administration, *National Energy Modeling System: An Overview 2003*, 2003. Report No. DOE/EIA-0581(2003).
2. U.S. Department of Energy - Energy Information Administration, *Annual Energy Outlook 2003: With Projections Through 2025*, January, 2003. Washington, DC. Report No. DOE/EIA-0383(2003). <<http://www.eia.doe.gov/oiaf/aeo>>